

SECTION 432113
HORIZONTAL PUMPS

PART 1 - GENERAL

101. **EXTENT**

- 101.1 This Section prescribes the minimum requirements for horizontal pumps and horizontal slurry pumps complete with all accessories. The CONTRACTOR shall conform to the requirements of this Section and to the requirements indicated on the design drawings
- 101.2 The slurry pumps covered in this section include, but not limited to: recycle spray pumps, absorber bleed pumps, hydroclone underflow pumps, belt filter feed pumps, mill product pumps, and limestone slurry feed pumps. Slurry pumps shall be designed to accommodate the pumping fluid as described in section 441130.
- 101.3 The water pumps covered in the section include, but not limited to: reclaim water pumps, mist eliminator wash pumps, and flush water pumps.
- a. The above mentioned pumps shall be supplied for 100% capacity.
 - b. In addition, each pump mentioned above shall be provided with one 100% capacity spare.
 - c. Flush pumps shall be capable of flushing all CONTRACTOR (and DISTRICT as applicable) furnished slurry pumps and slurry process piping, valves and nozzles include in the absorber, reagent preparation and dewatering areas including recycle piping, headers and nozzles.
- 101.4 CONTRACTOR shall provide but not be limited to, design, fabrication, delivery, installation support and service for horizontal pumps and horizontal slurry pumps necessary to complete the system functions and scope of work outlined in this Specification.
- 101.5 CONTRACTOR shall be solely responsible for advising the DISTRICT in writing of any conflicts between the specification and the CONTRACTOR's design, including performance and levels of quality. CONTRACTOR agrees that obligations, liabilities and warranties shall not be diminished or extinguished due to meeting the requirements of the specification.
- 101.6 Unless noted otherwise, all equipment and/or systems provided by CONTRACTOR shall be controlled, monitored and alarmed via the DISTRICT's distributed control system (DCS). CONTRACTOR shall provide project specific control logic diagrams and project specific description of operation documents for all equipment. CONTRACTOR's logic diagrams shall be used by the DCS vendor for programming and configuring the DCS. CONTRACTOR is required to participate in the factory acceptance testing for the DCS and to certify that the DCS logic has been implemented per CONTRACTOR's control logic diagrams including any requirements for operation and performance. CONTRACTOR shall not claim the DCS as the limiting factor in the operation and performance of CONTRACTOR-supplied equipment.

102. **RELATED WORK SPECIFIED IN OTHER SECTIONS**

- 102.1 The work specified in this Section shall be coordinated with work specified in the following related Sections:

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Specification G-5301
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September 8, 2011
Project No. 12681-006

- a. Section 014219 - Reference Documents
- b. Section 261850 – Medium Voltage Motors
- c. Section 262950 – Low Voltage Motors
- d. Section 441130 – Wet Flue Gas Desulfurization Systems

103. DESIGN REQUIREMENTS

103.1 Pump Type and Design:

- a. Pumps shall be of the horizontally mounted centrifugal type, directly connected to motor drives. Each pump, except close-coupled type pumps, shall be connected to the motor drive through a flexible coupling.
- b. Each pump and motor drive, except close-coupled type, shall be mounted on a common bedplate.
- c. Pumps shall be of the heavy-duty type suitable for continuous service over 30 years in a power plant environment. Each pump shall operate without undue strain or wear and without damage to any part of the pumping unit. CONTRACTOR shall determine the exact type of pump design which will provide such service without operating difficulty or undue replacement of parts.
- d. Pumps shall be designed and constructed for the most severe service conditions under which the pumps will be required to operate. All materials of construction shall be identified with ASTM or AISI standard numbers. All features of design and construction and all materials shall be acceptable to DISTRICT.
- e. All parts of each pump unit shall be designed to withstand stresses resulting from a full voltage start of the motor.
- f. CONTRACTOR shall be responsible for determining that each pump and driver operate in dynamic balance as a unit without undue vibration.
- g. The vibration levels specific to motors shall be tested by the manufacturer and shall not exceed the limits specified by NEMA standard.
- h. Wear rings, impellers, shaft sleeves and other parts (either rotating or stationary) forming the pump assembly, shall be securely locked in place, and liberally designed and renewable.
- i. Pumps shall be capable of both intermittent (start-stop) and continuous operation under flow conditions from minimum to run-out conditions.
- j. Pumps shall be designed for continuous unattended service while operating within the limits of the operating range.
- k. Centrifugal slurry pumps shall be direct or gear drive connected to motor drives. Each pump, except gear driven, shall be connected to the motor through a flexible coupling.
- l. Pump discharge outlet shall be flanged unless otherwise specified. Discharge flange shall match the ANSI or AWWA standard pipe flange as specified. CONTRACTOR shall submit information on the maximum allowable external piping forces and moments on the pump discharge nozzles.

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- m. CONTRACTOR shall have the responsibility for the materials selection in the construction of the equipment and accessories. The material selection shall be suitable for the severity of the service intended. Materials application shall be compatible with the fluids handled and the range of operating conditions specified. All materials of construction shall comply with the requirements set forth in Section 441130 – Wet FGD.
- n. All materials of construction shall be identified with ASTM, AISI or equivalent standard numbers.
- o. All rotating parts shall be statically and dynamically balanced. If pump impeller geometry does not allow dynamic (two-plane) balancing, then a minimum single-plane balancing shall be provided.

103.2 Pump Characteristics:

- a. The difference in flow for centrifugal pumps operating in parallel shall not exceed 5% throughout the operating range.
- b. Each pump shall have a stable, steadily rising head characteristic curve with capacity suitable for the service specified. Each pump and motor combination shall have nonoverloading characteristics. The first critical speed of the pumps shall not lie within a region of 125% of rated speed. The shutoff head shall be less than 130% of the design head.
- c. When duplicate pumps are furnished, all components, including spares and spare assemblies, shall be completely interchangeable.
- d. Duplicate pumps designed for the same conditions shall operate satisfactorily in parallel with each other and with other pumps of similar characteristics.
- e. The pump characteristics shall include a net positive suction head required (NPSH_R) curve that represents 3% head deviation at the "break-way" points. A minimum margin of 25%, or CONTRACTOR's recommended margin if more stringent, must be maintained between NPSH_R and net positive suction head available (NPSH_A) values for normal continuous operation at all flows, including maximum runout.
- f. High head pumps with Total Developed Heads of 500 ft or greater which are subjected to frequent changes in load or cycles of operation, shall be designed with impellers supported between bearings. Pump speed shall not exceed 1800 rpm.
- g. To avoid excessive vibration, CONTRACTOR shall verify that the critical speed of each combined pump unit specified herein is at least 25% above the operating speed (rpm). The critical speed and potential resonant frequency shall consider the entire pump system including its bearings and supports. Calculation of critical speed based on a pump rotor with infinitely stiff bearings is not acceptable.
- h. The unfiltered vibration levels as measured on the bearing housing shall not exceed the level specified by the Hydraulic Institute at design speed and flow conditions. This same vibration level shall also not be exceeded when the pumps are coming up to speed or when operating at less than the specified flow.

103.3 Equipment Sound Levels:

The warranted maximum A-weighted sound level shall not exceed 85 dBA (dB re: 0.0002 microbar) at any point one meter from the pump and appurtenances measured under any operating conditions in accordance with the "Hydraulic Institute Code for Measurement of Airborne Sound from Pumping Equipment."

104. REFERENCE DOCUMENTS

104.1 Standards, specifications, manuals, codes and other publications of nationally recognized organizations and associations are referenced herein. Methods, equipment and materials specified herein shall comply with the specified and applicable portions of the referenced documents indicated in Section 014219, in addition to federal, state or local codes having jurisdiction. References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the applicable additions, addenda, amendments, supplements, thereto, in effect as of the date indicated in Section 014219.

104.2 AISI - American Iron and Steel Institute

104.3 ANSI - American National Standards Institute

a. B31.1 - Power Piping

104.4 API - American Petroleum Institute:

a. 610: Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries

104.5 ASME - American Society of Mechanical Engineers:

a. Boiler and Pressure Vessel Code, Section VIII, Division 1

104.6 ASTM - ASTM International

104.7 AWWA – American Water Works Association

104.8 AWS – American Welding Society

104.9 HI - Hydraulic Institute

104.10 ISO – International Organization for Standardization

104.11 PTC 8.2 – Performance Test Code for Centrifugal Pumps

105. SUBMITTALS

105.1 Submit documents for review in accordance with Section I – Contract Drawing and Data Requirements.

106. GENERAL QUALITY CONTROL AND QUALITY ASSURANCE PROVISIONS

See Section 014500 – Quality Control for more information.

107. HANDLING AND STORAGE

Refer to Section F – General Conditions for shipping requirements. CONTRACTOR shall ensure that pumps and appurtenances are shipped on skids and shop fabricated to the greatest extent possible.

108. PROJECT/SITE CONDITIONS

Refer to Section 011900 Site Design Data.

109. SCHEDULING

Refer to Section 013216 Project Schedule.

110. MAINTENANCE

110.1 Special Tools:

A complete set of all-special equipment and tools required for repair, adjustment and complete dismantling and assembling of the equipment shall be furnished. Tools shall be new and of first-class quality. Tools shall be shipped to the project in separate containers clearly marked with the name of the equipment for which they are intended.

PART 2 - PRODUCTS

201. ACCEPTABLE MANUFACTURERS AND PRODUCTS

Refer to section 012513 – Acceptable Suppliers and Product Substitutions.

202. COMPONENTS

202.1 Casing:

- a. Pumps shall be of the horizontal, vertical split-case or end-suction design, constructed to permit ease of access for inspection, removal of rotating element and replacement of wearing parts without disconnecting the suction and discharge piping and without disturbing pump alignment.
- b. Lifting lugs or eyes shall be provided as required.
- c. Centrifugal pumps shall be provided with high point vents and low point drains for proper priming and drainage. Casing vent and drain openings shall be provided and plugged.
- d. Pumps operating at temperature over 250°F shall be centerline supported.
- e. Pump suction and discharge connections shall match ANSI Standard pipe flanges.
- f. Pump suction and discharge connections shall match ANSI Standard pipe flanges.
- g. Slurry pump casings shall be fitted with replaceable abrasion resistant natural rubber liners, pressure molded to steel backing plates, and secured to the casing externally by heavy duty studs and nuts. The rubber liners shall extend through the casing nozzles to form gaskets between the pump suction and discharge flanges and the mating piping. The liners shall be designed to resist collapsing.

202.2 Shaft Seals:

- a. Mechanical seals shall be of the pressure-balanced type, seal design and materials shall be tested and proven most suitable for the service conditions. The seals shall be equipped with all necessary accessories to flush and cool the seal faces as required to provide maximum service life of the seal parts.
- b. Stuffing boxes shall be jacketed for water cooling, where required.

- c. Packed stuffing boxes shall be designed to reduce leakage to a minimum and shall be provided with highest quality packing held in place by split-type stuffing box glands. Labyrinth shall be provided, where necessary, to break down the water pressure on the packing.
- d. Water injection-type seals (if furnished) shall be adequate and appropriate for the service requirements of the pump. Necessary sealing water injection and bleed-off connections shall be provided by CONTRACTOR.
- e. Mechanical seals and water injection-type seals shall be protected from excess discharge pressure, where necessary, by means of suitable pressure breakdown chambers or other approved pressure-reducing devices.
- f. External seal water source shall be provided with a self-regulated system. All pumps shall be complete with integral piping, valves, filters assemblies and instrumentation, for detection of seal water flow and pressure for alarm, interlock and start permissive in DISTRICT's DCS, to ensure proper operation.
- g. All pumps shall have a provision for collection and drainage of leakage around the shaft seal. Leak-off drains shall be neatly piped to the bedplate drain outlet.

202.3 Impellers:

- a. Each impeller shall be bored, accurately fitted, rigidly keyed and locked to shaft. All rotors shall be dynamically balanced with all rotating parts connected thereto.
- b. Slurry pump impellers shall have a natural rubber jacket. If CONTRACTOR believes a jacketed impeller is not required or appropriate, they may specify another design subject to approval by DISTRICT or Consulting Engineer.

202.4 Shaft and Sleeves:

- a. Pump shaft shall be forged steel and shall be accurately finish ground. The coupling end shall be tapered to match the coupling bore.
- b. Shaft sleeves shall be provided on all pump shafts. They shall be designed and fitted to protect the shaft from wear and corrosion at points in contact with stuffing boxes and other wearing parts, and in corrosive or erosive service shall also protect the shaft from contact with the liquid being pumped.
- c. Centrifugal slurry pump shafts shall have replaceable sleeves at points of wear. They shall be designed and fitted to protect the shaft from wear and corrosion at points in contact with stuffing boxes and other wearing points and in corrosive or erosive service. Sleeves shall also protect the shaft from contact with the liquid being pumped.

202.5 Wearing Rings:

- a. Wearing rings shall be provided on all impeller entrances and on both the impeller and casing when so required for severe service. Design of rings shall be such as to be easily renewed and maintained in service and to reduce leakage to a minimum.
- b. For slurry pumps the rubber casing lining shall constitute the wearing ring.

202.6 Bearings:

- a. Main bearings shall be of sleeve or ball type conforming to the following:
 - a1. Sleeve Bearings: Horizontally-split, self-aligning, forced feed or ring oil lubrication. Wear surfaces shall be of babbitt or other approved antifriction alloy.
 - a2. Sleeve bearings shall be furnished with Chromel-Constantan thermocouples and of the type specified.
 - a3. Ball Bearings: Balls and races shall be of hardened steel. Bearings may be either grease or oil lubricated as approved. Sizes and types to be interchangeable with standard makes.
 - a4. Thrust Bearings: Amply sized and easily adjustable. Thrust bearings where required shall be "Kingsbury" self-contained type.
- b. General Requirements:
 - b1. Antifriction bearings shall have an ANSI/AFBMA L10 life of 150,000 hours. For water pumps, a shaft mounted slinger shall be provided to deflect water. Radial and axial forces shall not be transmitted to the motor.
 - b2. Bearings shall be located and arranged to facilitate alignment, maintenance and to permit easy replacement.
 - b3. Suitable provisions shall be made to prevent throwing of grease or oil, and to prevent contamination from moisture or dirt.
 - b4. One end of pump or driver shaft shall be accessible for taking speed readings with a portable tachometer.

202.7 Piping

- a. CONTRACTOR shall provide interconnecting piping between components furnished by CONTRACTOR. Piping connections should be welded, insofar as possible, except welding neck or slip-on flanges may be used where required for dismantling and maintenance.
- b. Piping shall be preassembled on the bedplate as much as possible.

202.8 Oil Piping:

- a. All external oil piping shall be of steel construction with welded joints and forged steel fittings, except steel welding neck or slip-on flanges may be used where required for dismantling and maintenance.
- b. All oil piping shall be thoroughly cleaned at the factory before it is installed. All lines shall be thoroughly cleaned out after they are installed so as to preclude the possibility of dirt or any other foreign material being present in the system when the pump(s) are placed in operation.

202.9 Welding

Structural and support welding shall be performed in accordance with AWS D1.1. Welding or repair welding of pressure parts and components shall be in accordance with CONTRACTOR's procedures with shall conform to all applicable codes and standards. Welder performance tests shall be according to ASME Section IX.

202.10 Pump Bedplate:

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- a. The pump and driver, with the exception of motor-driven close-coupled pumps, shall be bolted to a common bedplate that shall extend under and beyond all parts of the pump and driver.
- b. Bedplate shall be drilled by CONTRACTOR to suit the actual drilling in the motor base in order to ensure correct matching of holes.
- c. Pump shall be properly aligned with the driver and dowelled to its bedplate.
- d. Bedplate shall be manufacturer's standard type with a continuous raised drip lip around all four sides and fitted with two liberally sized tapped drain wells. All outside surfaces of bedplate shall have a smooth and finished appearance.
- e. Bedplates shall be provided with a sufficient number of grouting holes and adequate vents to allow air to escape during grouting so as to prevent voids from forming in the grout.
- f. Bedplates shall be made of heavy steel or cast iron and shall be rigid enough to transmit the manufacturer's acceptable loads to the foundation without causing misalignment of the pump / motor shafts to exceed the recommended limits of the coupling manufacturer and without deforming the seals beyond the permissible limits recommended by the seal manufacturer.
- g. Rolled or bent steel bedplates are not acceptable.
- h. Pump and driver shall be properly aligned and doweled to the bedplate, at the factory. Jacking screws shall be provided on the bedplate to facilitate field alignment work.

202.11 Shims:

Pumping unit design, with exception of close-coupled type, shall provide 1/8-inch shim space between bedplate and motor feet. Metal shims not more than 1/32-inch thick and of full size and shape of motor feet shall be provided.

202.12 Couplings and Guards:

- a. A flexible shaft coupling with spacer, of make and type as approved, shall be provided on all pumps, except close-coupled type. The spacer length shall be designed to allow dismantling the pump bearings, shaft seals, coupling halves and pump internals without disturbing the motor or piping. The pump end coupling half shall have a tapered bore.
- b. Coupling guards and all other guards necessary for protection against external moving parts shall be provided on the pumps. Guards shall be of substantial sheet steel construction suitably braced and reinforced and mounted on an angle-iron frame. Guards shall be of a type acceptable to the Consulting Engineers.
- c. No keys shall extend beyond coupling guards.

202.13 Accessories

- a. A temporary suction strainer shall be furnished. The basket shall be of stainless steel material as a minimum. Otherwise the material shall be suitable for the pumped liquid. The strainer shall be designed such that the NPSHr plus a nominal 10% margin is not violated when the strainer is 50% plunged.

- b. Acoustic insulation shall be provided if needed to meet the specified sound levels. The acoustic insulation shall be designed for the environment in which the pump is installed and for easy removal and reinstallation to provide access for maintenance of covered equipment.
- c. Case vent and drain valves shall be provided. The valve rating shall be selected based on the maximum expected pressure and temperature combination that could exist with the pump operating at shut off. Piping and fittings connecting the valves to the pump casing shall be provided and of comparable rating. Valve and pipe materials shall be compatible with the pump casing material and suitable for the pumped liquid. The valves shall be located and positioned to be easily accessible for maintenance and operation.

202.14 Electrical Requirements:

Refer to section 260000 for all electrical requirements.

203. MATERIAL REQUIREMENTS

All slurry pumps shall be comprised of materials suitable for the equilibrium chlorides specified by CONTRACTOR. All pipe/pumps shall be rubber-lined to fit the slurry requirements.

204. SOURCE QUALITY CONTROL

204.1 Test Curves:

Although the design point is of primary importance in the warranty, any pump is subject to rejection at the time the test curves are received unless they indicate the following:

- a. The As-Tested Head-Capacity Curve:
 - a1. The curve shall be stable, steadily rising from the design point to shutoff.
 - a2. Rise-to-shutoff shall be within specified limits. If no such limits are specified, it is understood that the permissible variation of the percent rise-to-shutoff is plus or minus 15% of the proposal curve percent rise. For example, if the proposal curve rise-to-shutoff is 20%, the permissible variation on the plus and minus sides are 23% and 17%, respectively.
- b. The As-Tested Horsepower Curve:
 - b1. Design point (warranted) horsepower shall not be exceeded at any point from zero capacity to design capacity.
 - b2. The curve shall have values not exceeding the corresponding proposal curve values in the runout area. As an alternative, so as to cover overshoot of head, the proposal curve may indicate a warranted maximum horsepower at design and a warranted maximum horsepower at runout.
- c. The As-Tested NPSH Curve:
 - c1. Shall have values less than the design (warranted) NPSH at all capacities below design capacity.
 - c2. Shall have values not exceeding the corresponding proposal curve values in the runout areas.
 - c3. Shall state the test conditions of speed and water temperature and basis of the test curve, i. e., 3% head loss across the first stage at the "break-away" points.

- d. If the test curves are rejected based on deviations from the above requirements, it is understood that all corrective measures are to be at the CONTRACTOR's expense. If the pump cannot be corrected, the DISTRICT shall be reimbursed the full contract cost of the pumps and specified appurtenances.
- e. Reference to the recommendations of the "Hydraulic Institute" does not excuse the CONTRACTOR from complying with the above requirements or others specified herein. If there is any reason to refer to Standards of the Hydraulic Institute, the reference must be supported by actual reproductions from documents involved, which will be subject to review by the Consulting Engineers.

204.2 Shop Tests:

- a. A factory performance test of net developed head, efficiency, brake horsepower and NPSH required vs. flow shall be performed on each pump, at design operating.
- b. All tests shall have a minimum of five flow points, including minimum flow, the specified design flow and runout flow (or 125% of design flow, whichever is greater).
- c. Efficiencies and brake horsepower shall be determined preferably by use of a calibrated torque measuring device. Alternately, a motor furnished for the pump can be used for the shop tests if the motor performance has been tested and certified by the manufacturer.
- d. If a certified motor is used to determine pump efficiency and brake horsepower, the tolerances of the electrical instruments used on the pump tests shall be factored into the test readings so that the calculated power input at the pump coupling would be the maximum expected values.
- e. A shop performance test shall be performed to the HI Standards Level A. The more restrictive procedures and acceptance criteria, between this specification and HI Level A, will govern.
- f. An NPSHr test, vibration test and sound level test shall be performed with the shop performance test.
- g. CONTRACTOR shall furnish a pump performance test report which, at a minimum, describes the tests performed and provides the results. This report shall also discuss any standard test corrections the CONTRACTOR makes to achieve the final results.
- h. Vibration shall be tested in the radial direction, in two orthogonal positions at each radial bearing and in the axial direction at the thrust bearing. Values shall not exceed the required limits, at the guaranteed rated flow and operating speed.

205. FABRICATION REQUIREMENTS

205.1 Steel per AISC, etc.

205.2 Preparation for Shipment:

- a. All exposed machined ferrous metal surfaces shall be coated with a suitable antirust compound before shipment.
- b. All inlets and outlets shall be plugged or blanked off before shipment.

206. FINISH REQUIREMENTS

206.1 Before shipment, all parts of the equipment shall be thoroughly cleaned of all mill scale, rust, grease, and other foreign matter. External nonmachined ferrous surfaces shall be given one prime coat of

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manufacturer's standard high-quality paint. Paint shall be suitable for the service and acceptable to the Consulting Engineers.

- 206.2 No paint having an asphaltum base shall be used.
- 206.3 Surfaces with operating temperatures above 250°F that are not covered with insulation and lagging shall be painted with a heat-resistant paint.
- 206.4 Refer to section 099113 Coatings for additional information on finish and coatings.
- 206.5 All exposed machined ferrous metal surfaces shall be coated with a suitable anti-rust compound before shipment.
- 206.6 All inlets and outlets shall be plugged or blanketed before shipment.

PART 3 – EXECUTION

301. FIELD SERVICES

- 301.1 Services of competent technical personnel to provide advice, assistance and guidance in the unloading and erection of the equipment furnished under this Specification. The technical personnel shall cooperate with DISTRICT's erection contractor.
- 301.2 After all instruments and controls covered by this Specification required for operation of the equipment are installed and ready to operate or are operating, a capable serviceman shall inspect them, approve the installation, and give assurance in writing to DISTRICT that the instruments are properly installed, ready for service, and are correct within the limits of the guarantee.
- 301.3 Services of competent startup engineer(s) to instruct, advise, and train DISTRICT's personnel in the correct startup, safe operation, and maintenance procedures, testing and placing of the equipment in successful service.
- 301.4 Necessary technical services as required to resolve preliminary operating problems as they develop until satisfactory operation is achieved. Field technician services for manufacturing errors shall be paid for by CONTRACTOR.
- 301.5 Necessary offices and office equipment required by his field personnel. DISTRICT will furnish outdoor space or floor area only for such purposes.
- 301.6 Field personnel shall be capable, qualified, and able to perform the duties required to the satisfaction of the DISTRICT and shall be vested with authority to make decisions binding on CONTRACTOR.

302. TESTING

- 302.1 Hydrostatic Test
 - a. All pressure containing and vacuum parts of the pump shall be given a hydrostatic test of 1½ times the design pressure or 1¼ times the maximum expected shutoff discharge pressure, whichever is greater (per the HI standard), but not less than 50 psig. Zero leakage shall be demonstrated for a period of five minutes.
 - b. The hydrostatic test shall be performed with ambient temperature water.



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- c. Gaskets and O-rings used during the hydrostatic test shall be identical to the ones supplied with the pump. The gaskets used during the hydrostatic test shall be replaced with new gaskets.
- 302.2 Each pump component shall be given factory tests as necessary to determine that the work and materials are free from defects. Examination, inspection and testing of any component and pipe materials shall be in accordance with applicable requirements of ANSI/ASME B31.1.
- 302.3 CONTRACTOR shall assure through testing that the equipment furnished will perform in accordance with the specification. One pump from each item or duplex set shall be tested over full operating range by CONTRACTOR. The tests will be reviewed by DISTRICT.
- 302.4 DISTRICT shall conduct performance tests, after equipment is completely installed, to demonstrate satisfactory operation of equipment. CONTRACTOR shall (if required) arrange to have his authorized representative present to witness and assist in the test.
- 303. TRAINING
See section 017900 for training requirements.

END OF SECTION 432213

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